#### 2004 DOE Program Review Presentation

Hydrogen Generation from Electrolysis

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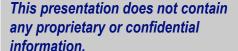
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## **Objectives**

- Power
  - To advance water electrolysis technology and develop an Electrolytic Hydrogen Generator with the following features:
    - Delivers hydrogen at high-pressure, 5,000 psig
      - Develop a relatively inexpensive hydrogen generation & pressurization solution
        - Collaborate with compressor manufacturer
        - Collaborate with power supply manufacturer
    - Production capacity 10,000 scfd
    - High conversion efficiency
    - Cost objective < \$600/kW for 10,000 units per year</li>
    - Reliable, low maintenance cost, & durable





## **Budget**

- ▶ Total funding for the project = \$3,127,764
  - **◆ DOE share = \$1,563,882**
  - **◆ TESI share = \$1,563,882**
- ▶ Total funding in FY04 = \$490,000
  - ◆ DOE share = \$245,000
  - **◆ TESI share = \$245,000**

Power Systems

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#### **Technical Targets & Barriers – Efficiency**

Base	Based on 2005 Targets & LHV of H <sub>2</sub>				
Characteristic	Target	<u>Barrier</u>			
Power Conversion	Efficiency = 96%	AC to DC: Turndown ratio & rectification technology DC to DC: Matching power source with the H2 Generator			
Cell Stack	Efficiency = 70%	Membrane resistance, catalyst technology, corrossion due to hi-temp operation			
Balance of Plant	Efficiency = 97%	Gas purification technology & other parasitic losses			
Compression	Efficiency = 90%	High-pressure gas generation and motor & compression technology			

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#### **Technical Targets & Barriers – Cost**

Based on 2005 Targets & LHV of H <sub>2</sub>					
Characteristic	Target	<u>Barrier</u>			
Power Conversion	Cost = \$0.21/kg	Mfg & Rectification			
		technologies			
Cell Stack	Cost = \$0.79/kg	Mfg & Production technology			
Balance of Plant	Cost = \$0.14/kg	Gas purification & mfg			
		technology			
Compression	Cost = \$0.21/kg	Compression & mfg			
	406-11-0	technology			

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### **Approach**



- Small-scale membrane testing & development for high-pressure and high-efficiency
- Conceptual system optimization
  - Pressure vs. hardware cost trade studies (As the system and compressor pressures increase, the cost of components increases.)
- Optimize cell, stack, & system designs
  - Catalysts
  - Parasitic loss reduction
  - Power supply & compressor optimization
  - Design for manufacturing & assembly

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# **Project Safety**

- TESI has over 30 years of commercial hydrogen generation and safety related experience.
  - Users are trained to safely operate the systems.
  - Generators are typically monitored for crosscontamination and out-of-tolerance conditions.
  - Generator installation areas are constantly monitored for hydrogen concentrations and sometimes infrared emissions.
- HAZOP & FMEA studies will be performed as part of the trade studies and on final system.

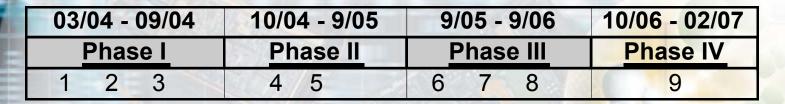
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# **Project Timeline**



- Phase I Feasibility
  - 1. High-pressure membrane testing
  - 2. High-pressure cell design & testing
  - 3. Component trade studies
- Phase II System Conceptualization
  - 4. System conceptual design & trade studies
  - 5. Stack modeling & design

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# Project Timeline (cont'd)

03/04 - 09/04	10/04 - 9/05	9/05 - 9/06	10/06 - 02/07
Phase I	Phase II	Phase III	Phase IV
1 2 3	4 5	6 7 8	9

- Phase III Finalize design & Implementation
  - 6. Complete system design & component selection
  - 7. DFMA studies
  - 8. Build demo unit
- Phase IV Site Test

9. Factory test & deliver demo unit to site, begin site testing, performance verification, public awareness & education

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#### Interactions & Collaborations

- AeroVironment Inc.: Charles Botsford Maximizing safety, reliability, power conversion efficiency, and reducing cost.
- Pdc Machines, Inc.: Sy Afzal Maximizing safety, reliability, & compression efficiency, and reducing cost.
- Maryland Energy Admin.: W. Dale Baxter Cooperation for providing a demonstration site and public education & awareness.

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#### **Future Work**

PRODUCT PORTFOLIO





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